In accordance with the present invention, as indicated above, a need exists to effectively deliver voice traffic on the Homenetworking (HPNA V2) network. Of note is the need to get the voice traffic to operate within performance goals within the HPNA V2 network. In particular, issues dealing with an A/D converter sampling circuit clock synchronization on the home network, and issues dealing with packet boundaries and when to take a set of samples and call it a packet for use on the home network, need resolution.

Consider the application of voice data in conjunction with the home network, in general. How data is packaged and how higher layer information is communicated are issues which need to be addressed. When the home has a connection point (e.g., a gateway) to the public telephony systems, video / voice high speed data networks, and a phone service provider wishes to supply phone service along with high speed data, one technique is to provide a cable modem instead of having a traditional modem for connection to an internet service provider (ISP). With the cable modem, a computer can be connected thereto to allow the user to have a very high speed data service. The high speed data service provider may also wish to provide video feeds, phone service over the same network. The cable modem could also contain connection points to allow the phones in the home to be connected to the cable modem, that is, the analog phone signal goes into the cable modem and gets converted to appropriate digital signals for transmission from the cable modem to the public telephony network. U.S Patent Application 09/501,850 entitled "Cable Modem System with Sample and Packet Synchronization", now U.S. Patent No. 6,834,057, owned by the Assignee of the present application and incorporated herein by reference, describes such a system. When the HPNA V2 system is also employed in the home to provide local area network interconnection for the transfer of digital data, such HPNA system can be connected to the cable modem. In turn, if the

Best Available Copy

variable gain amplifier (VGA) 470, filter 480 for low-pass anti-aliasing, VGA 490, and is similarly coupled to phoneline connector 450 through electronic hybrid 440 and filter / transformer / electronic protection circuit 445. Electronic hybrid 440 and filter / transformer / electronic protection circuit 445 are connected therebetween by a plurality of transmit and receive lines (e.g.,TX, RX1, RX2) 495. The operations of the analog front end are well known in the art.

Homenetworking PHY Layer Overview

In accordance with a preferred embodiment of the present invention PHY 320 uses 4 MBaud QAM modulation and 2 MBaud Frequency Diverse QAM (FDQAM), with 2 to 8 bits-per-Baud constellation encoding, resulting in a PHY-layer payload modulation rate that ranges from 4 Mb/s to 32 Mb/s. The modulation techniques are set forth in U.S. Patent Application No. 09/169,552 entitled "Frequency Diverse Single Carrier Modulation For Robust Communication Over In-Premises Wiring", now U.S. Patent No. 6,327,311 which is incorporated herein by reference. Information is transmitted on the transmission medium / channel in bursts. Each burst or physical layer frame consists of PHY-layer payload information encapsulated with a PHY preamble, header and postamble. The PHY-layer payload in each physical frame is that part of the Ethernet Link Level frame that follows the Ethertype field through the Frame Check Sequence (FCS), plus a CRC-16 and a pad field for the 4 Mbaud rate. Hereafter, "payload" refers to the PHY-layer payload unless otherwise specified.

Referring to Fig. 5, a transmitter aspect of PHY 320 is shown in functional block diagram form. Transmitter 500 includes frame processor 510, data scrambler 520, bit-to-symbol mapper (constellation encoder) 530, and QAM / FDQAM modulator 540. The frame format transmitted by transmitter 500 is shown in Fig.6. Frame format 600 consists of low-rate header section 610, a

priority always contend in the slot corresponding to the access priority. Instead stations at non-zero Backoff Levels defer contending until stations that are at zero Backoff Level transmit. The method used is called Distributed Fair Priority Queuing (DFPQ) as described in co-pending application no. ~~09/0267,884,~~ 09/026,884 now U.S. Patent No. 6,256,317 the content of which are expressly incorporated by reference herein. Each station maintains eight Backoff Level (BL) counters, one for each priority. The Backoff Level counters are initialized to 0. The priority level of a collision can be inferred from the priority slot where the collision occurs. Consider the case where stations are only contending on one priority. After a collision and an IFG, three special Backoff Signal slots (S0…S2) are present before the normal sequence of priority contention slots occurs. Signal slots only occur after collisions, they do not follow successful transmissions. Each active station pseudo-randomly chooses one of the slots, and transmits a Backoff Signal. More than one station can transmit a Backoff Signal in the same slot. The active stations transmit Backoff Signals to indicate ordering information that determines the new Backoff Levels to be used. All stations (even those without a frame ready to transmit) monitor collision events and the Backoff Signal slots to compute the Backoff Level. If an active station sees a Backoff Signal in a slot prior to the one it chose, it increases its Backoff Level. Those stations at Backoff Level 0 (ones that are actively contending) that saw no Backoff Signals prior to the one they chose, remain at Backoff Level 0 and contend for transmission in the priority slot equal to TX_PRI that immediately follows the Backoff Signal sequence. Eventually, only one station remains at Backoff Level 0 and successfully gains access to the channel. Stations with higher priority waiting frames may pre-empt the collision resolution by transmitting in a higher-priority slot. All stations, even those not contending for access to the wire, also maintain a Maximum

Reply frame, the receiver uses the demodulation statistics for this frame, and any previously received Rate Test Reply frames using this encoding, to make a decision as to the channel's capability to support the tested band encoding. If the decision is that the channel is not capable of supporting the tested band encoding, the receiver does not generate another Rate Test Request frame for at least 128 seconds. If the decision is that the channel is capable of supporting the tested band encoding, the receiver may repeat the test to collect more data, at a maximum rate of one RateTest Request frame every second, with a maximum of 16 additional tests. At this point, the receiver generates a Rate Change Request to the sender specifying the new band encoding. Support for Rate Test Reply frames is only required in stations that implement additional bands beyond Band1. Stations that only implement Band1 silently discard received Rate Test Reply frames. Whenever a transition to Compatibility mode occurs, the receiver PE is set to a value of 8 for all channels for a period of 60 seconds, to match the Sender nodes' behavior. Whenever a transition to V2 mode occurs, the receiver PE is set to a value of 1 for all channels.

The Link Integrity Function is now more fully described. In addition to the implementation aspects set forth hereinbelow, the concepts set forth in related co-pending U.S. Patent Application No. 09/619,553 entitled "A Method And Apparatus For Verifying Connectivity Among Nodes In A Communication Network", which is incorporated herein by reference. The purpose of the Link Integrity Function is to provide a means for hardware and/or software to determine whether or not this station is able to receive frames from at least one other station on the network. In the absence of other traffic, a station periodically transmits a Link Integrity Control Frame (LICF) to the Broadcast MAC address, with the interval between such transmissions governed by the method described below.

mapping, then it always uses the priority of the next lower valid mapping. Consider the following example. If the CurrentInuse, are [0,1,4,7], then the corresponding set of in-use PHY priorities is [2,0,4,6]. Then increase each by the number of missing higher priorities:, 2->5, 0->4, 4->6 and 6->7. Just to be safe, the any unused PHY priorities are also remapped to the new value of the next lower in-use priority, giving: 1->4, 3->5, 5->6, 7->7. So the in-use LL priorities [0,1,4,7] result in transmitting PHY priorities [5,4,6,7]. A complete map for all the LL priorities adds the remaining remapped values for the default priorities corresponding to the unused LL priorities: LL[0,1,2,3,4,5,6,7] gives PHY[5,4,4,5,6,7,7].

Now turning to the Limited Automatic Repeat reQuest (LARQ) in more detail, the operation of which is set forth in pending U.S. Patent Application No.09/316,541 entitled "Limited Automatic Repeat Request Protocol For Frame-Based Communications Channels", now U.S. Patent No. 6,335,933 which is incorporated herein by reference. This is a protocol that reduces the effective error rate when frame errors occur. Its primary distinction from similar, sequence number-based protocols is that it does not guarantee reliable delivery of every frame, but instead conceals errors in the physical layer through fast retransmission of frames. The goal is to significantly enhance the usability of networks that may, at least occasionally, have frame error rates (FER) of 1 in 10^{-2} or worse. Protocols such as TCP are known to perform poorly when FER gets high enough, and other applications, such as multi-media over streaming transport layers, are also susceptible to poor performance due to high FER conditions. The protocol provides a negative acknowledgment (NACK) mechanism for receivers to request the retransmission of frames that were missed or received with errors. There is no positive acknowledgment mechanism. There is no explicit connection setup or tear-down mechanism. A reminder mechanism gives receivers a second chance to detect missing

present invention includes three functional aspects: (1)a channel estimator, the concepts of which are described in co-pending application No. 09/585,774, entitled "Method and Apparatus for Efficient Determination of Channel Estimate and Baud Frequency Offset Estimate", now U.S. Patent No. 6,625,459 and which is incorporated by reference herein; (2) a noise floor estimator; and (3)a unique field match (either SRC or SI+SRC or SRC+DST or SI+SRC+DST).

In accordance with the present invention a method and apparatus is provided for generating a preamble sequence to facilitate channel estimation and noise floor estimation. A sequence b is defined as the 16 symbols set forth below.

$$\mathbf{b} = \begin{bmatrix} b_0 \\ b_1 \\ . \\ . \\ b_{15} \end{bmatrix} = \begin{bmatrix} 1+i \\ -1-i \\ -1-i \\ -1-i \\ 1+i \\ 1-i \\ 1+i \\ -1+i \\ 1+i \\ 1+i \\ -1-i \\ 1+i \\ 1+i \\ -1+i \\ 1+i \\ 1-i \end{bmatrix}$$

This sequence has an important property that

This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☑ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: ______________________

IMAGES ARE BEST AVAILABLE COPY.
As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.